

Comprehensive Sewer Rehabilitation Design and Field Investigation in Jefferson County Summary and Case Studies

DANIEL WHITE AND TINA SHEIKHZEINODDIN

Jefferson County Sewer Service Area

500,000 Residents Served

9 Water Reclamation Facilities

3,107 Miles of Sewer

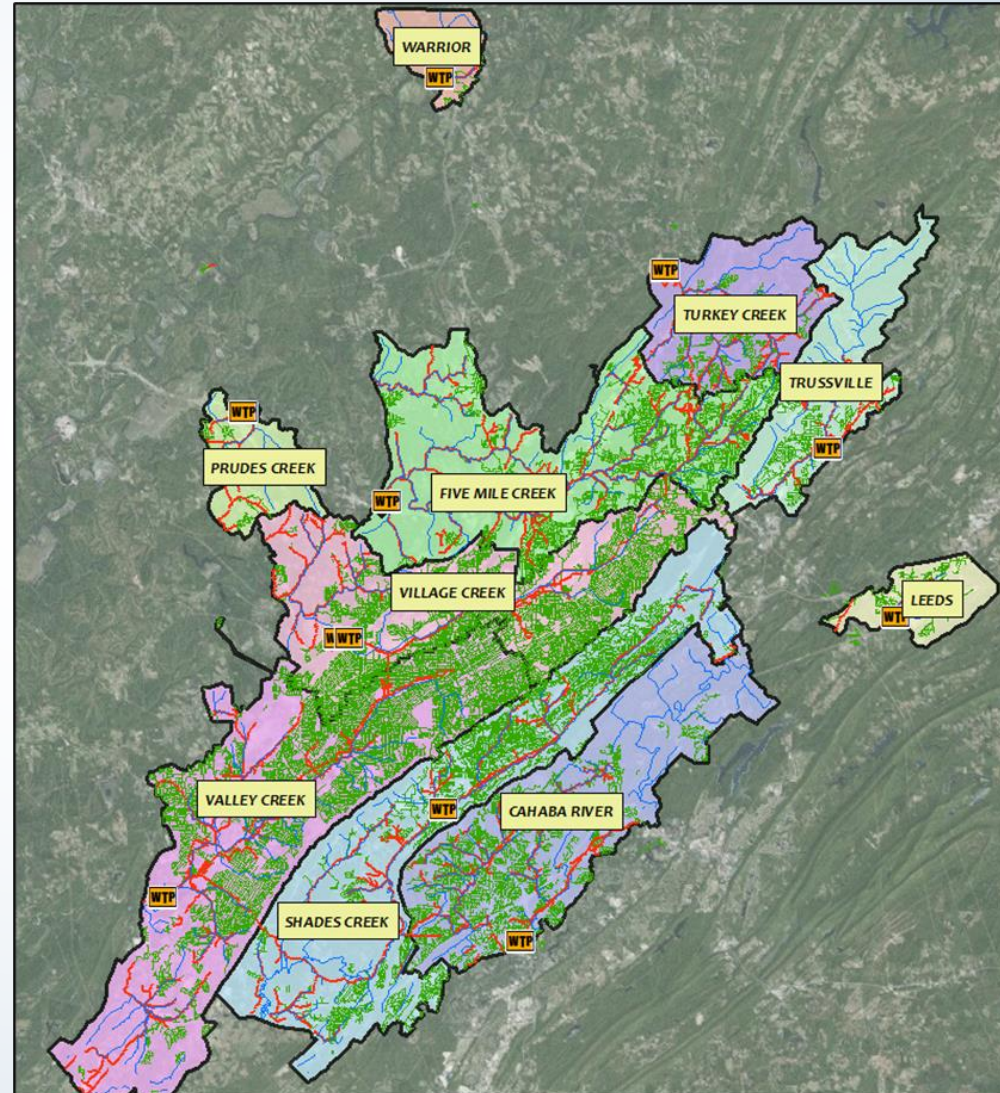
- 83% ≤ 8 " diameter
- 17% ≥ 10 "-146" diameter

82,905 Manholes

178 Pump Stations

107 Miles of Force Main

103 MGD ADF



Jefferson County System - Background

1996 Consent Decree

- \$2.4 Billion (1996-2006)
- Over 3 million LF of Cured-In-Place Pipe
- Nearly 400,000 LF of Open Cut

2011-2013 Bankruptcy

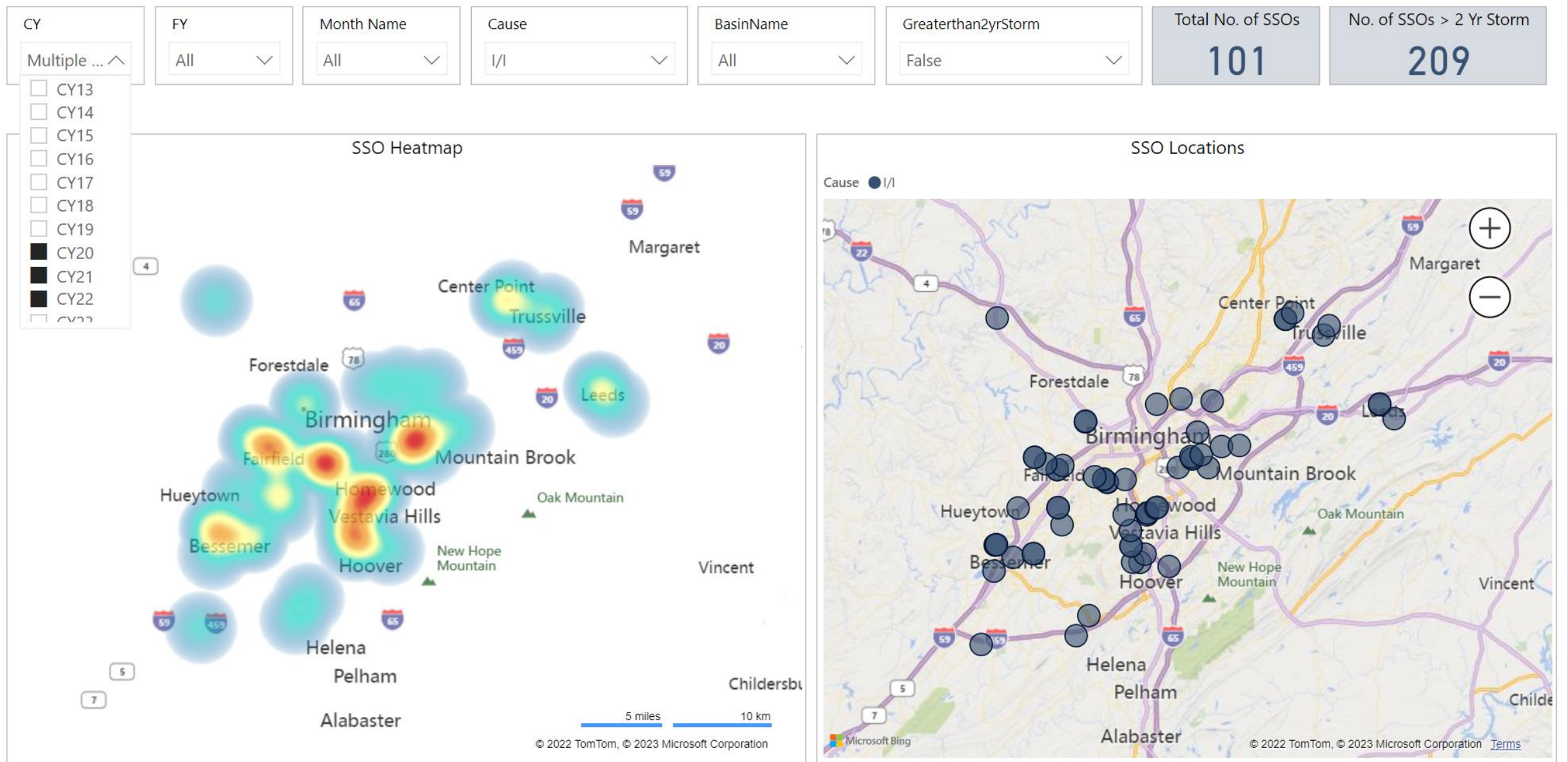
- Limited capital funding

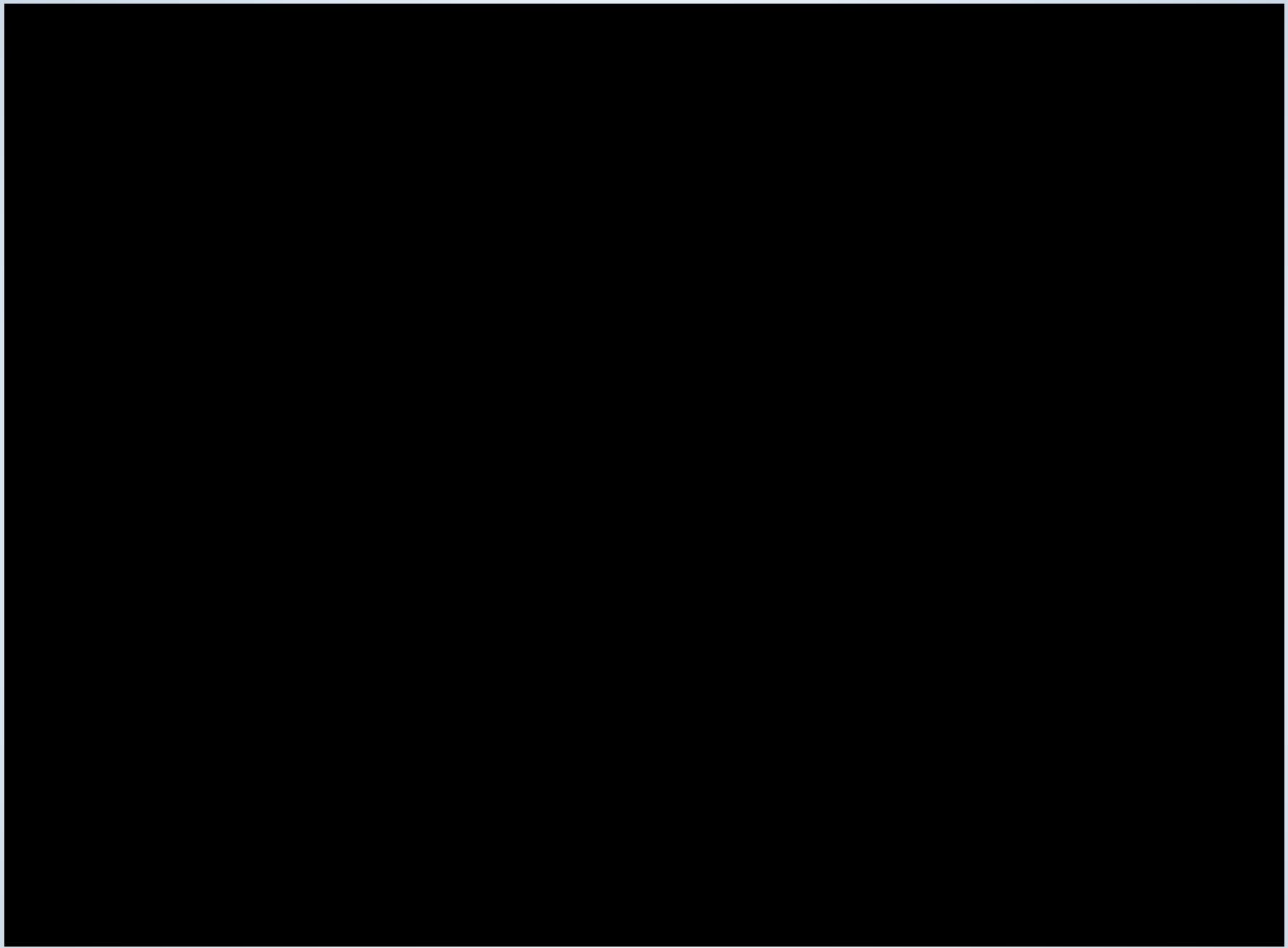
Asset Management 2013-2018

- Hydraulic Modeling
- "Traditional" Remedial Measures Plans
 - Bigger Pipes and Peak Flow Storage for capacity
 - CIPP a structural solution for asset renewal

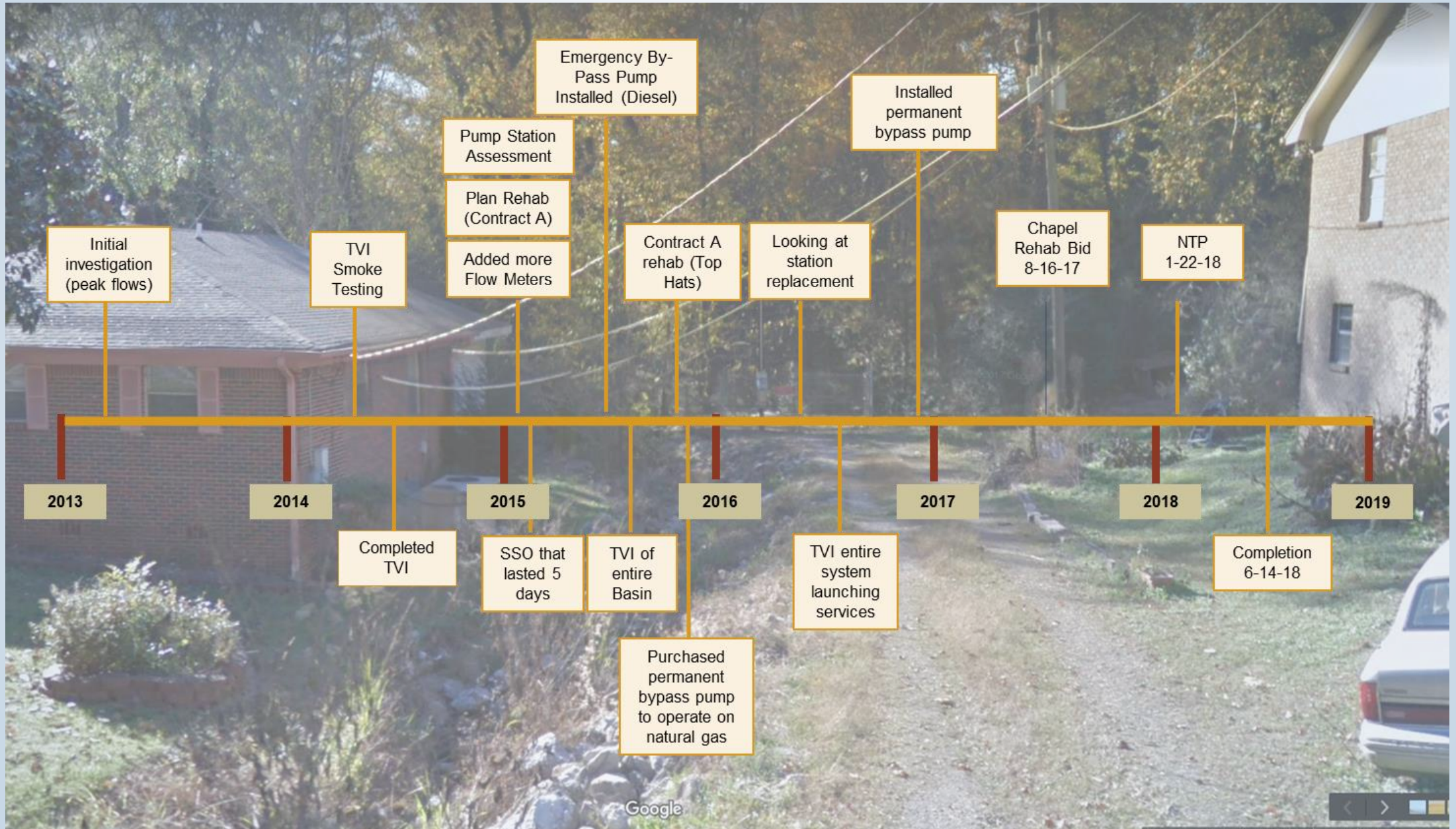


Wet-Weather SSOs





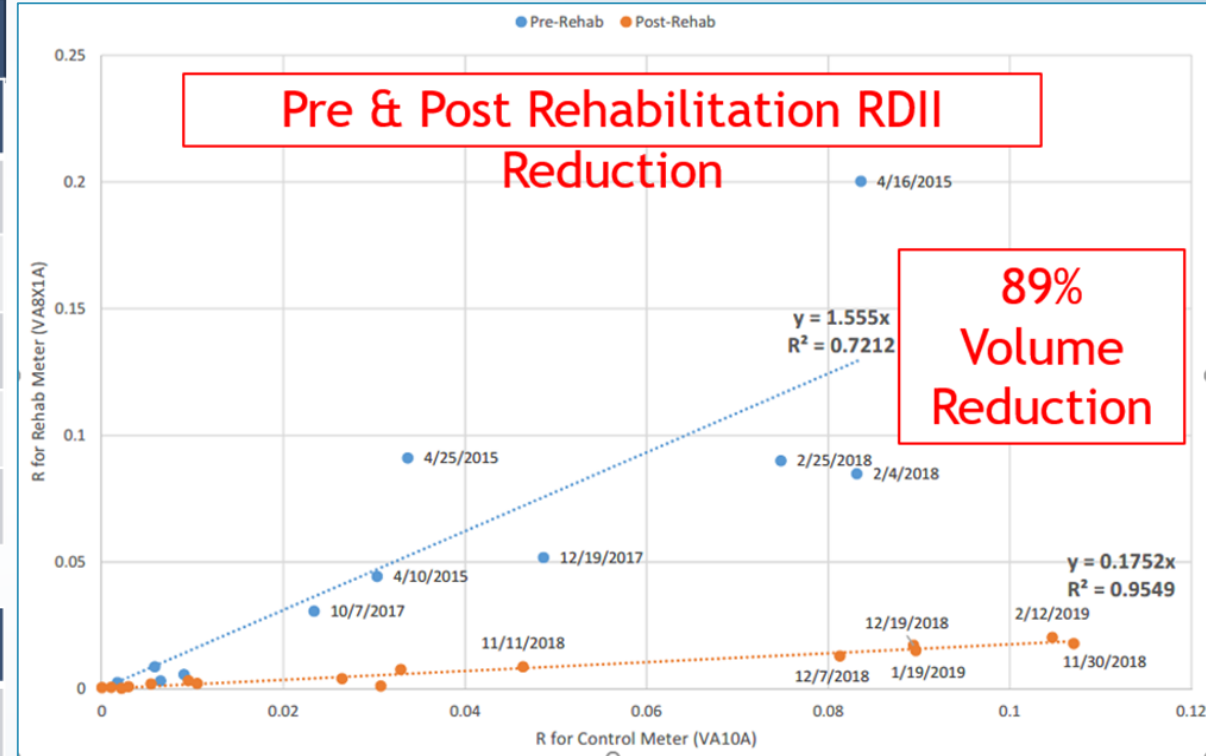
Chapel Drive Pump Station



Results Too Good to Ignore

Upsizing	
Item	Cost
1,780 LF of 15-inch Gravity Pipe	\$700,000
1,020 LF of 6-inch Force Main	\$140,000
New 0.6 MGD Pump Station	\$360,000
Construction Contingency (30%)	\$360,000
Total Construction Cost	\$1,560,000

Comprehensive Rehabilitation	
Cost as Bid	\$810,295.50
Cost at Closeout	\$776,381.50



2018 Chapel PS No. 2 Pilot Lateral Lining

Should We Change Course?

Challenges

- Significant capital expenditure required to resolve SSOs
- Large range of alternatives for consideration
- Complex hydraulics and system-wide interdependencies
- Limited budget

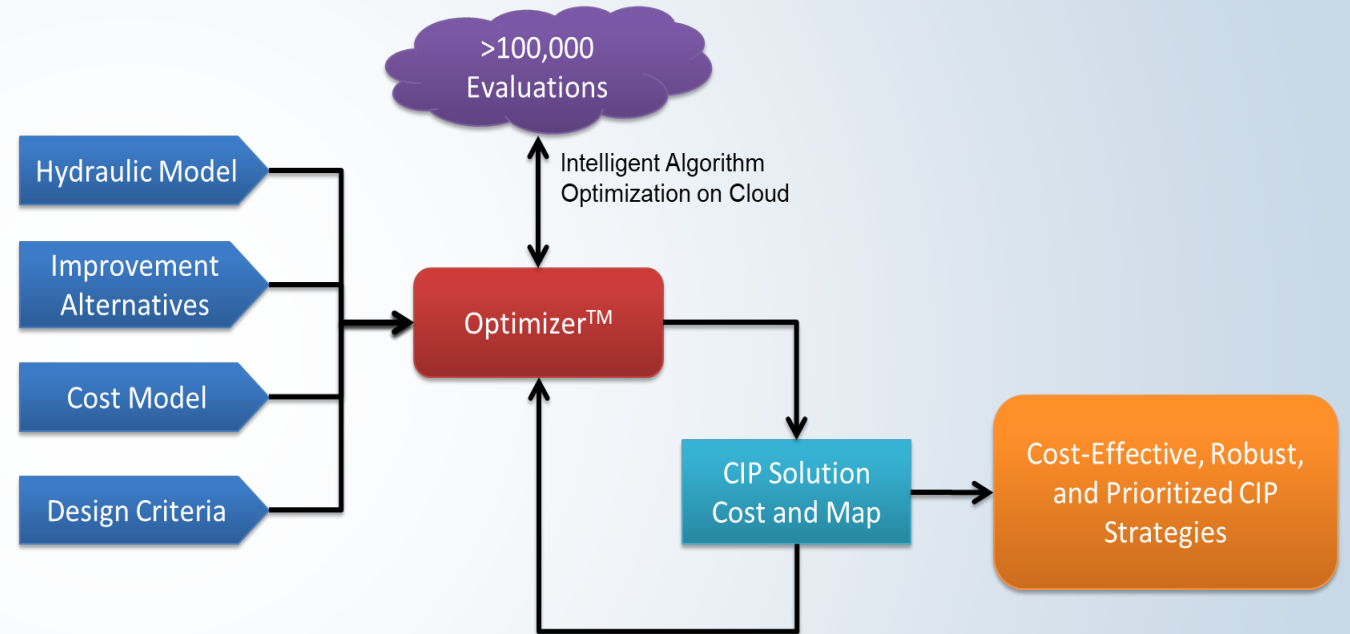
Solutions

- System-wide optimization of SSO remedial measure alternatives
- Intelligent algorithm optimization and cloud computing to find the system-wide planning strategy that meets the design criteria at least cost
- Prioritize the sequence of implementation to maximize return on investment



System-Wide Optimization Study

- Collaborated with WCS Engineering to do a system-wide optimization of SSO remedial measure alternatives based on life cycle cost
- Incorporated County dynamic model
- Design scenario used: future conditions (2040) and worst case of 2-year, 6-hour and 2-year, 24-hour design storm
- Evaluate conveyance, storage, inflow and infiltration (I/I) reduction, treatment and inter-basin diversion alternatives
- Prioritize implementation schedule to maximize ROI



LEGEND

SANITARY SEWER OVERFLOWS

- > 1.0 MG
- ≤ 1.0 MG
- ≤ 0.5 MG
- ≤ 0.05 MG

SEWER CAPACITY

- $Q_{max}/Q_f > 1.5$
- $Q_{max}/Q_f > 1.0$

FREEBOARD

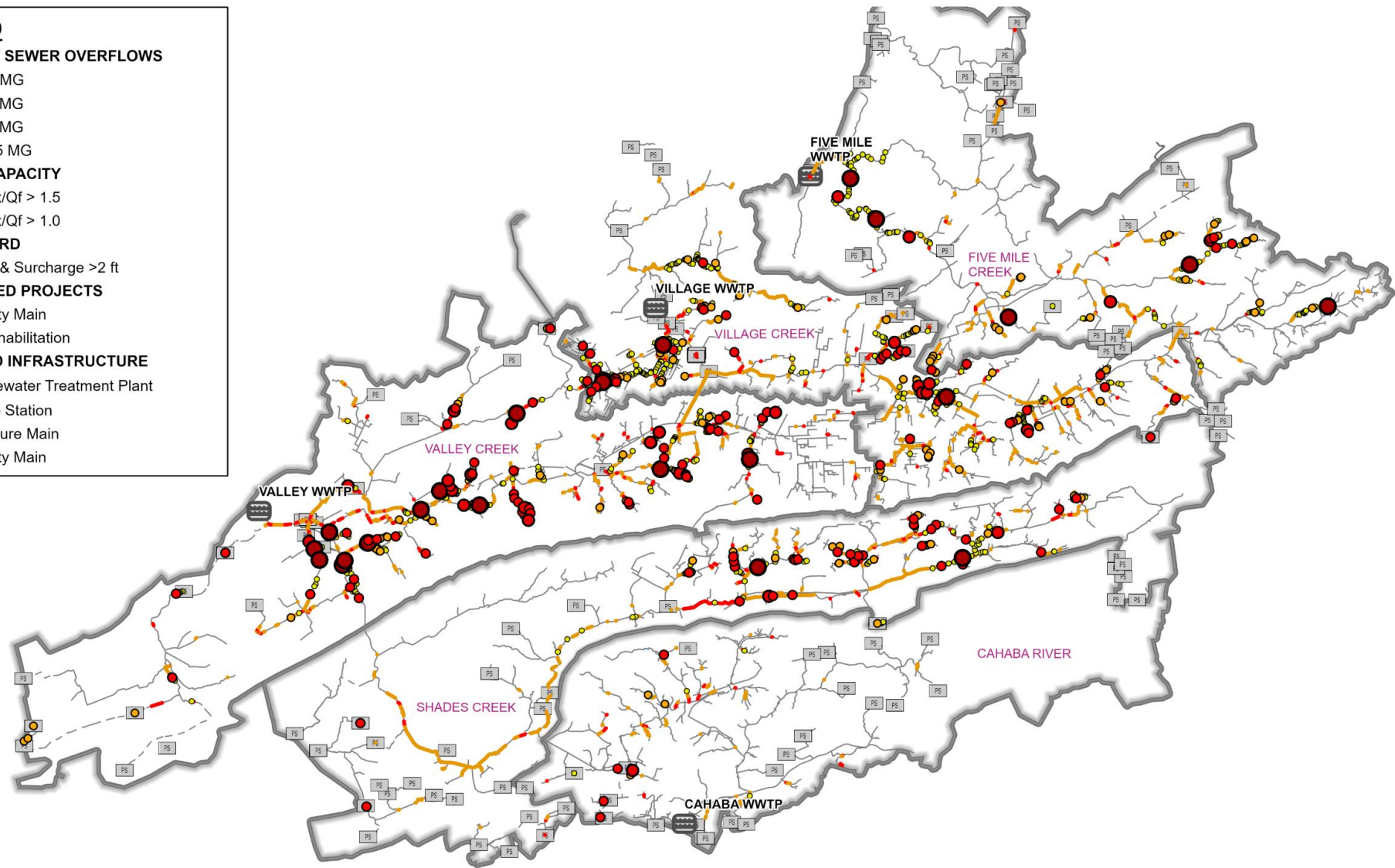
- < 2 ft & Surge > 2 ft

COMMITTED PROJECTS

- Gravity Main
- I/I Rehabilitation

MODELLED INFRASTRUCTURE










- ☒ Wastewater Treatment Plant
- PS Pump Station
- - - Pressure Main
- Gravity Main







CITY WIDE OPTIMIZATION
JEFFERSON COUNTY
EXISTING SYSTEM PERFORMANCE
CURRENT CONDITIONS

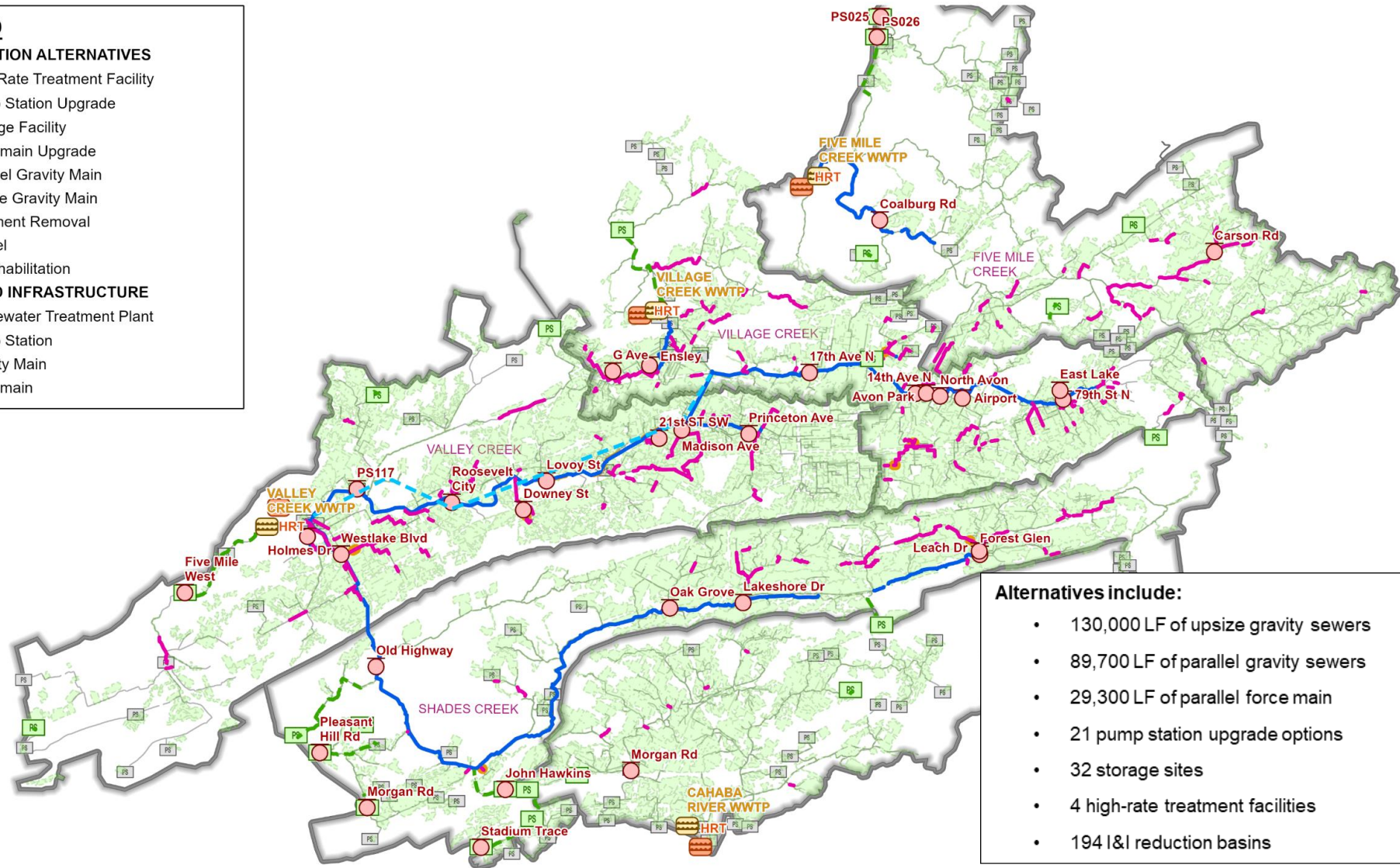
LEGEND

OPTIMIZATION ALTERNATIVES

-  High Rate Treatment Facility
-  Pump Station Upgrade
-  Storage Facility
-  Forcemain Upgrade
-  Parallel Gravity Main
-  Upsize Gravity Main
-  Sediment Removal
-  Tunnel
-  I/I Rehabilitation

MODELLED INFRASTRUCTURE

-  Wastewater Treatment Plant
-  Pump Station
-  Gravity Main
-  Forcemain



Alternatives include:

- 130,000 LF of upsized gravity sewers
- 89,700 LF of parallel gravity sewers
- 29,300 LF of parallel force main
- 21 pump station upgrade options
- 32 storage sites
- 4 high-rate treatment facilities
- 194 I&I reduction basins

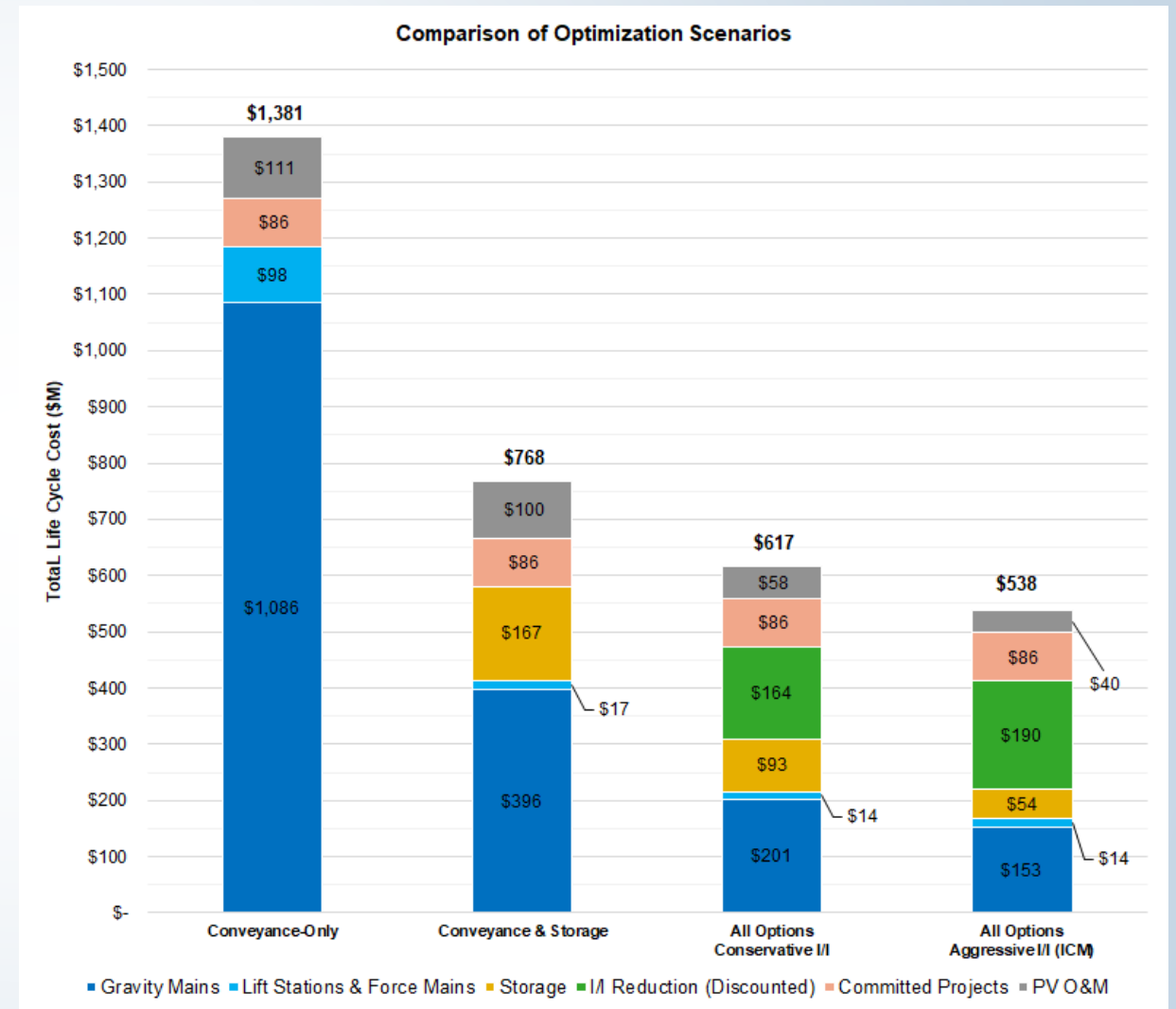


System-Wide Optimization Study

Optimization process evaluated various infiltration and inflow (I/I) reduction percentages

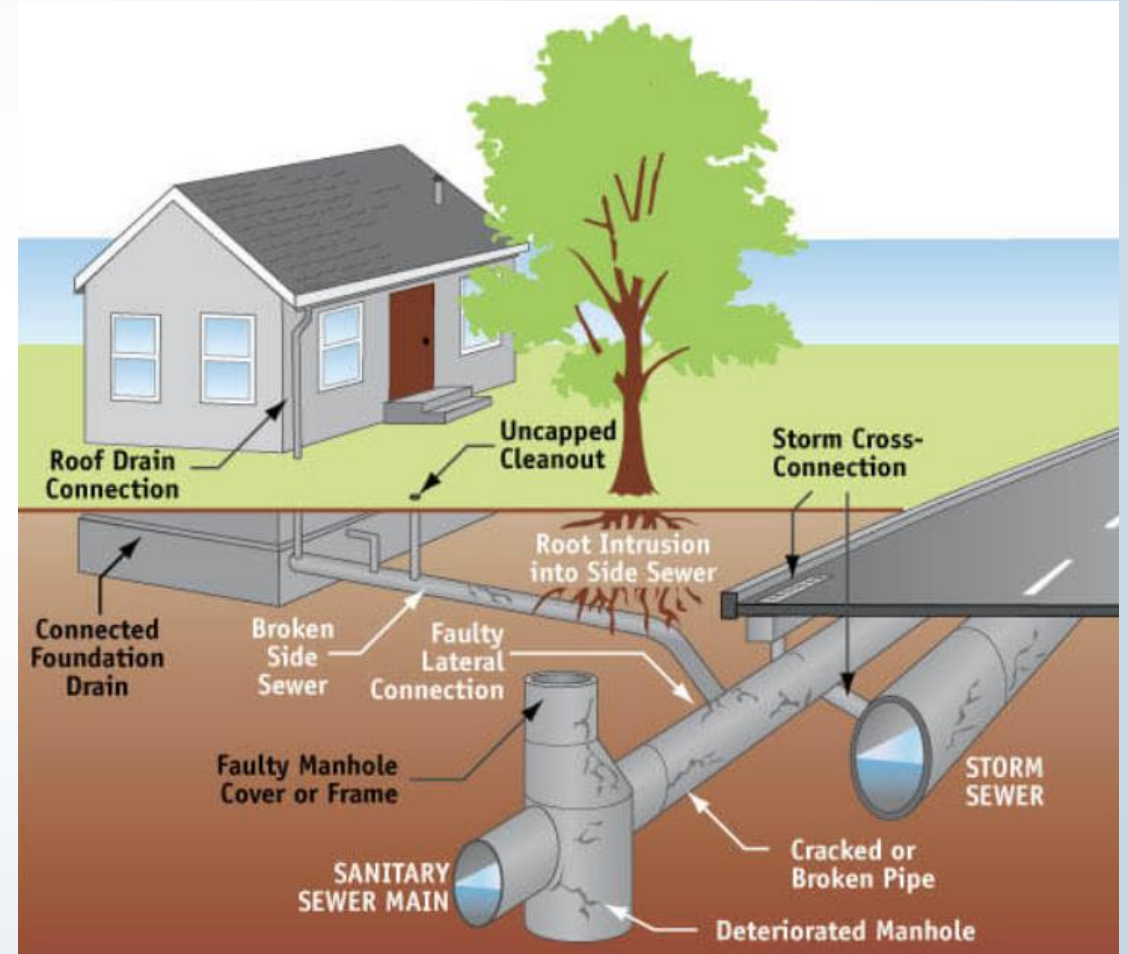
Determined the optimal balance between rehabilitation costs and downstream capacity improvement costs

The County has embarked on an extensive Comprehensive Sewer Rehabilitation Program for those areas where asset rehabilitation was selected as the most cost-effective solution



What Does Comprehensive Sewer Rehabilitation Look Like for Jefferson County?

- Cured-in-place (CIP) lining of all sewer mains
 - Lining over all inactive services (eliminates infiltration source with little additional cost)
- Service laterals
 - CIP lining of a portion of each live service lateral
 - SLCR (Service Lateral Connection Repair) of any live service in bad shape
 - ISL (Internal Sectional Liner) of inactive services on mainlines that have already been lined
- Manhole rehabilitation
 - Internal
 - Risers/Chimney
 - Frame/Cover
 - External

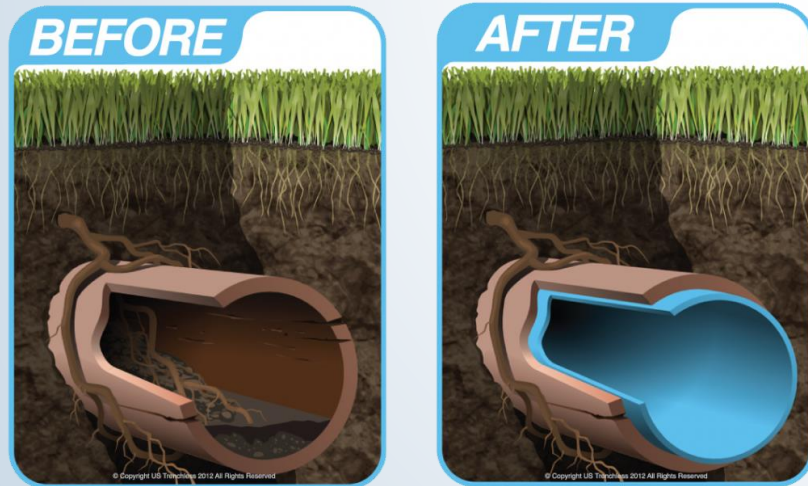


Comprehensive Rehabilitation - Mainline

Cured-in-Place Pipe (CIPP) Lining

End seals at manholes

All structural defects requiring excavation are repaired prior to lining (typically under a separate contract)



Comprehensive Rehabilitation- Lateral Launching

- Identifies active and inactive service laterals
- Sometimes it's a tough call whether a house is abandoned or not – does it look like it could be made livable again? Roof?
- Identifies significant defects at the lateral that will require excavation for repairs
- Especially beneficial in older neighborhoods with a large number of inactive services

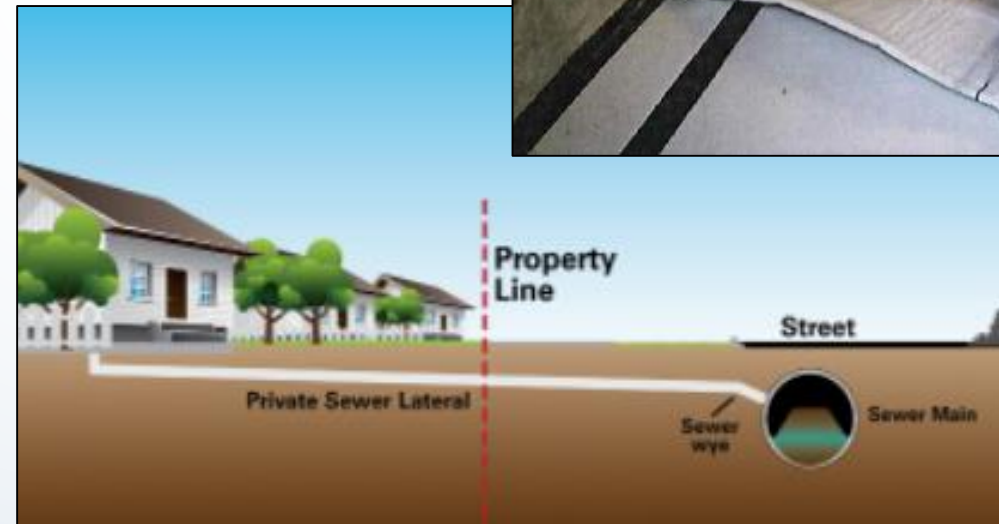


Comprehensive Rehabilitation – Service Laterals Work

Generally line 15' up the lateral

Full-Circle lateral lining

Only active laterals are reinstated following mainline CIPP



Comprehensive Rehabilitation - Manhole

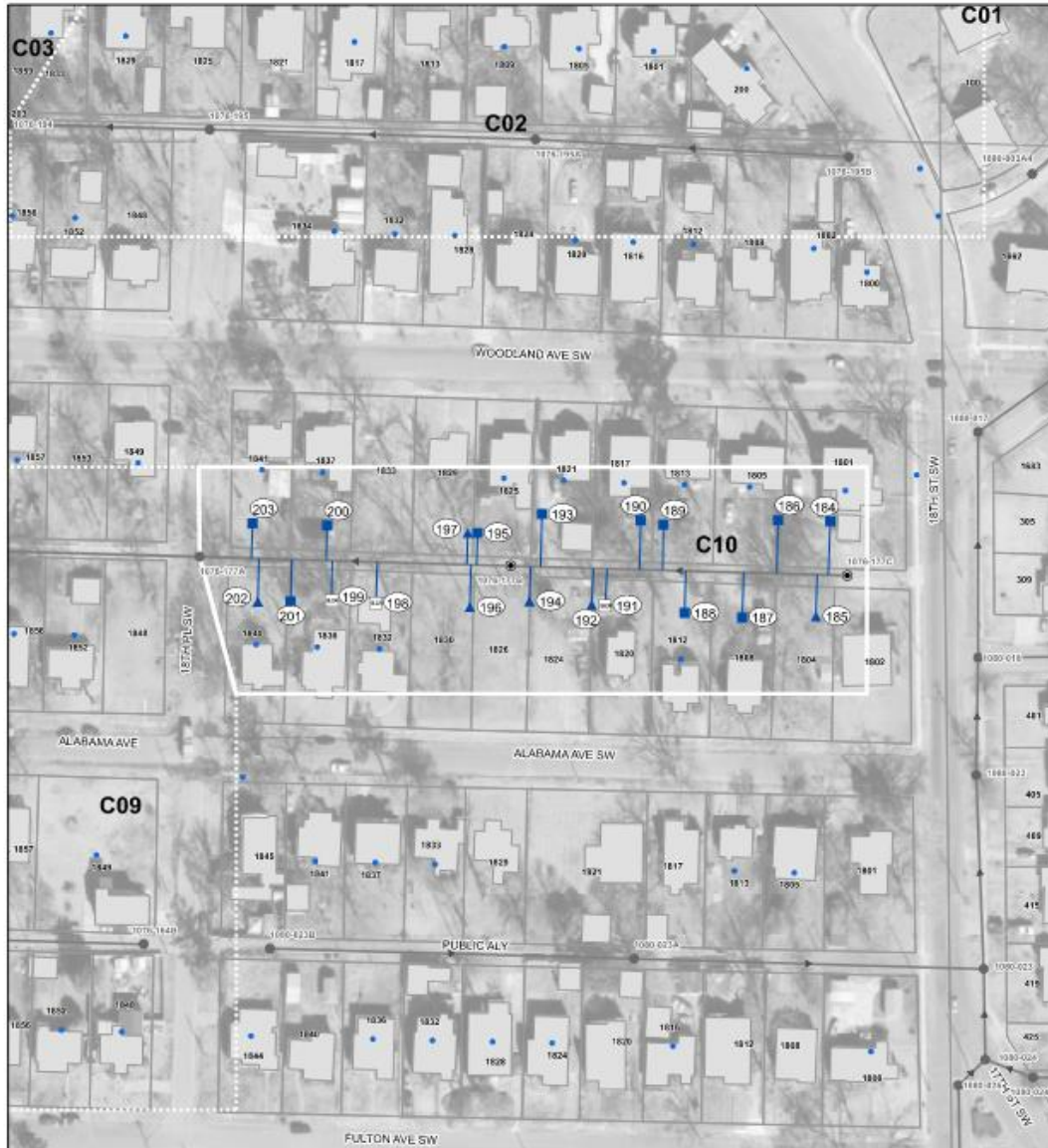
Internal Liner System

Chimney and Frame/Cover
Seals

Chemical Grouting

Manhole Inserts (i.e.
Rainstopper) to prevent
inflow where applicable





- NOTES:
1. LOCATIONS OF EXISTING SANITARY SEWERS ARE BASED ON THE BEST AVAILABLE INFORMATION. CONTRACTOR SHALL FIELD VERIFY AND NOTIFY ALABAMA 811 FOR UTILITY LOCATION AT LEAST TWO WORKING DAYS PRIOR TO ANY BACKFILL. CONTRACTOR SHALL FIELD VERIFY MANHOLES WITH NO DEPTH INFORMATION.
 2. IF A DISCREPANCY EXISTS BETWEEN THE INFORMATION SHOWN GRAPHICALLY AND THE REPAIR/REPLACE SCHEDULES, THE SCHEDULES SHALL GOVERN.
 3. REFER TO SHEET 022 FOR GENERAL AND CONSTRUCTION NOTES AND INDEX OF DRAWINGS.

MAINLINE REHABILITATION SCHEDULE

ASSET ID	ADDRESS	DIA (IN)	MATERIAL	USMH	DSMH	R/R TYPE	LENGTH (LF)	NO OF TAPS
GP001076-077061	1813 WOODLAND AVE SW, BIRMINGHAM, 35211	8	CIPP	1076-177C	1076-177B	-	280	11
GP001076-077062	1833 WOODLAND AVE SW, BIRMINGHAM, 35211	8	CIPP	1076-177B	1076-177A	-	259	9

SERVICE REHABILITATION/REPLACEMENT SCHEDULE

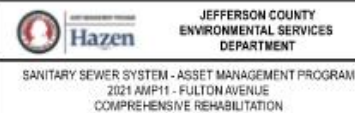
TAP ID	ADDRESS	ASSET ID	TAP DISTANCE (FT)	FROM MH	CLOCK POSITION	R/R TYPE
184	1801 WOODLAND AVE SW	GP001076-077091	263	1076-177B	10	CIPR
185	1802 ALABAMA AVE SW	GP001076-077091	242	1076-177B	3	ISL
186	1803 WOODLAND AVE SW	GP001076-077091	219	1076-177B	9	CIPR
187	1816 ALABAMA AVE SW	GP001076-077091	194	1076-177B	2	CIPR
188	1812 ALABAMA AVE SW	GP001076-077091	145	1076-177B	3	CIPR
189	1813 WOODLAND AVE SW	GP001076-077091	127	1076-177B	9	CIPR
190	1817 WOODLAND AVE SW	GP001076-077091	107	1076-177B	9	CIPR
191	1820 ALABAMA AVE SW	GP001076-077091	72	1076-177B	3	SLCR
192	VACANT LOT	GP001076-077091	69	1076-177B	3	ISL
193	1821 WOODLAND AVE SW	GP001076-077091	27	1076-177B	9	CIPR
194	1824 ALABAMA AVE SW	GP001076-077091	25.5	1076-177B	3	ISL
195	1826 WOODLAND AVE SW	GP001076-077092	231	1076-177A	9	CIPR
196	1835 ALABAMA AVE SW	GP001076-077092	225.5	1076-177A	3	ISL
197	1839 WOODLAND AVE SW	GP001076-077092	221	1076-177A	9	ISL
198	1833 ALABAMA AVE SW	GP001076-077092	149	1076-177A	3	SLCR
199	1836 ALABAMA AVE SW	GP001076-077092	97.5	1076-177A	3	SLCR
200	1837 WOODLAND AVE SW	GP001076-077092	96.5	1076-177A	9	CIPR
201	1845 ALABAMA AVE SW	GP001076-077092	66.1	1076-177A	3	CIPR
202	1845 ALABAMA AVE SW	GP001076-077092	47.2	1076-177A	3	ISL
203	1841 WOODLAND AVE SW	GP001076-077092	43.6	1076-177A	9	CIPR

MANHOLE REHABILITATION SCHEDULE

ASSET ID	DEPTH (FT)	R/R TYPE
MH001076-037166-177C	8	REHAB
MH001076-074856-177B	3.8	REHAB

- ⑧ Service Lateral Connection Tap ID
- Water Billing Information
- ISL - Internal Sectional CIP Liner
- ▲ CIPR - Cured-In-Place Service Lateral
- Service Lateral Connection Repair
- Manhole Rehabilitation
- Existing Manhole - No Action
- Gravity Mainline CIPP
- Gravity Mainline
- ++++ Force Main

PROJECT	T. POWELL
DATE	1/20/2022
DRAWN BY	A. ADL
CHECKED BY	E. HOFFMEYER
SCALE	AS SHOWN
DATE	01/20/2022



CIVIL PLAN SHEETS

DATE	APRIL 2022
PROJECT NO.	E2114
SHEET NO.	18 OF 46
DRAWING NUMBER	C10

BD SET

Comprehensive Rehabilitation – Data and Field Review

Detailed data review and field review have proven to be very important elements of the design process

Allows you to physically see the severity of structural defects

- Are they clustered?
- Are the defects line-able or will it require repairs be made first?

In some cases, this detailed review has shown that the defects are isolated and full comprehensive sewer rehabilitation is not required to reduce I/I, or the review has revealed a problem that requires a different solution





OF EXISTING SANITARY SEWERS ARE BASED ON THE BEST AVAILABLE INFORMATION. CONTRACTOR SHALL FIELD VERIFY AND
 IA 811 FOR UTILITY LOCATION AT LEAST TWO WORKING DAYS PRIOR TO ANY EXCAVATION. CONTRACTOR SHALL FIELD VERIFY
 EPTH INFORMATION.
 ANYCNY EXISTS BETWEEN THE INFORMATION SHOWN GRAPHICALLY AND THE REPAIR/REPLACE SCHEDULES, THE SCHEDULES
 EET G02 FOR GENERAL AND CONSTRUCTION NOTES AND INDEX OF DRAWINGS

PIPE REPAIR/REPLACE SCHEDULE

R/R TYPE	ASSET ID	DIA (IN)	USMH	DSMH	R/R LENGTH (LF)	NO OF TAPS	NOTES
SR	GP005007-032781	8	5007-349	5007-348	20	1	



ADDITIONAL INFORMATION TABLE

ASSET ID	REASON	GIS LENGTH	CCTV LENGTH	COMPLETE CCTV	MISSING CCTV	LINED	SAG	JOINT OFFSET	NOTES
GP005007-032781	Roots	196	167	Yes					

- Mt Oaks Dr - Drip Rock Ln Manholes
- Sewer Manholes (FOR REFERENCE ONLY)
- Segmental Replacement
- Mt Oaks Dr - Drip Rock Ln Hydroblast Gravity Mains
- Mt Oaks Dr - Drip Rock Ln Gravity Mains
- Gravity Mains (FOR REFERENCE ONLY)

DESIGNED: <u>AA</u>	DATE: _____
DRAWN: <u>AA</u>	SCALE: _____
CHECKED: <u>TS</u>	BY: _____
PROJECT: <u>AA</u>	DATE: _____
APPROVED: _____	DATE: _____



JEFFERSON COUNTY, ALABAMA
 ENVIRONMENTAL SERVICES DEPARTMENT
 SANITARY SEWER SYSTEM – ASSET MANAGEMENT PROGRAM
 CONTRACT NO. 2021 AMP14
 MT OAKS DR - DRIP ROCK LN COMP REHAB

**CIVIL
 PLAN AND REPAIR SCHEDULE
 FIELD REVIEW**

DATE: MAY 2021
HAS JOB NO: 31262-002
TASK: _____
PROJECT NUMBER: _____
DRAWING NUMBER: C06

Advantages of Comprehensive Rehabilitation

- Working in existing easements-no time delay
- Renewal of more assets for the same investment
- Less disruptive—trenchless
- Less expensive
- Reduced peak flow impact at treatment facilities

I/I Removal Results

Project Name	Bid Amount	Pre-Const Monitoring Period	Post-Const Monitoring Period	Target SSO Locations Removed (#, 2yr)	Target SSO Volume Removed (MG, 2yr)	Actual RDII Volume Reduction (%)
2017 AMP04- Chapel Drive Comprehensive Rehabilitation	\$810,296	Apr 2015 - Sep 2015	Aug 2017 - Jan 2021	2	0.66	89%
Fox Hollies Pump Station Comprehensive Rehabilitation		Dec 2019 - Mar 2020	Jun 2020 - Jun 2022	0	-	72%
Vulcan Pump Station Comprehensive Rehabilitation		Oct 2016 - Jan 2018	Mar 2020 - June 2022	22	-	85%

Work or Verification In Progress

Project Name	Bid Amount	Contractor	Target SSO Locations Removed (#, 2yr)	Target RDII Removal (%)	Target SSO Volume Modeled (MG, 2yr)
2021 AMP18 - Miscellaneous Comprehensive Rehab Contract 1 - Graysville Pump Stations	\$544,152	BLD	1	60%	0.08
2019 AMP01- Wylam PS Basin Comprehensive Rehabilitation	\$1,396,438	BLD	4	70%	0.75
2021 AMP15 - Brickyard Hills 32nd St Bessemer Comprehensive Rehabilitation (Phase 1)	\$1,612,081	BLD	2	70%	0.46
2023 AMP09- 72nd Street N Comprehensive Rehabilitation	\$1,898,652	BLD	2	30%	0.01
2020 AMP02- Comprehensive Rehabilitation Brighton PS Service Area	\$2,463,585	BLD	2	40%	0.43

Work or Verification In Progress

Project Name	Bid Amount	Contractor	Target SSO Locations Removed (#, 2yr)	Target RDII Removal (%)	Target SSO Volume Modeled (MG, 2yr)
2020 AMP02- Comprehensive Rehabilitation Oakwood PS Service Area	\$2,463,585	BLD	1	30%	0.2
2022 AMP13 - Miscellaneous Comprehensive Rehabilitation Contract 2-Lance Way	\$2,570,400	Suncoast	1	70%	0.31
2022 AMP13 - Miscellaneous Comprehensive Rehabilitation Contract 2- Lewisburg No. 1 PS's	\$2,570,400	Suncoast	0	Lower Run Times	0
2022 AMP13 - Miscellaneous Comprehensive Rehabilitation Contract 2-Walker	\$2,570,400	Suncoast	2	70%	0.51
2021 AMP17 - Hoover High School PS Comprehensive Rehabilitation	\$2,710,677	SAK	0	Lower Run Times	0

Work or Verification In Progress

Project Name	Bid Amount	Contractor	Target SSO Locations Removed (#, 2yr)	Target RDII Removal (%)	Target SSO Volume Modeled (MG, 2yr)
2021 AMP13 - Fargo Dr-Foothills Dr Comprehensive Rehabilitation	\$3,469,313	BLD	3	60%	0.99
2021 AMP14 - Mt Oaks Dr- Drip Rock Lane Comprehensive Rehabilitation	\$3,744,756	VIS	8	Area A: 40%, Area B: 50%, Area C: 60%	1.69
2021 AMP11 - Fulton Ave Comprehensive Rehabilitation	\$3,827,354	GCU	5	70%	0.97

Case Studies

Case Study 1 - Vineyards Pump Station

Problem and Background:

Pump station service area in a small residential neighborhood

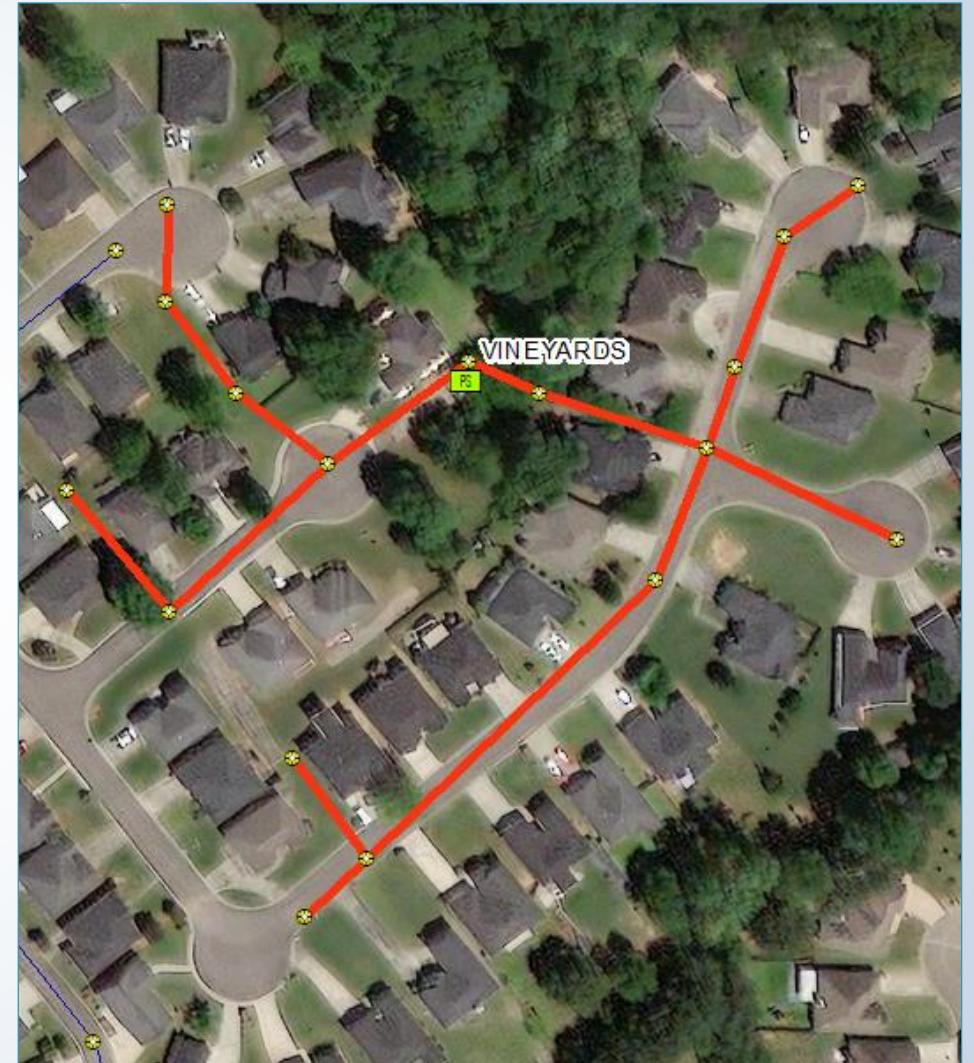
Unusually high run times following rain events

CCTV review showed the sewer mainlines were all relatively new DIP/PVC and in good shape

Only one infiltration source found at the manhole immediately upstream of the wet well (but inside the PS fencing)

Solution:

Approximately \$15k of manhole rehab and grout injection versus \$250k of comprehensive rehab in the PS service area



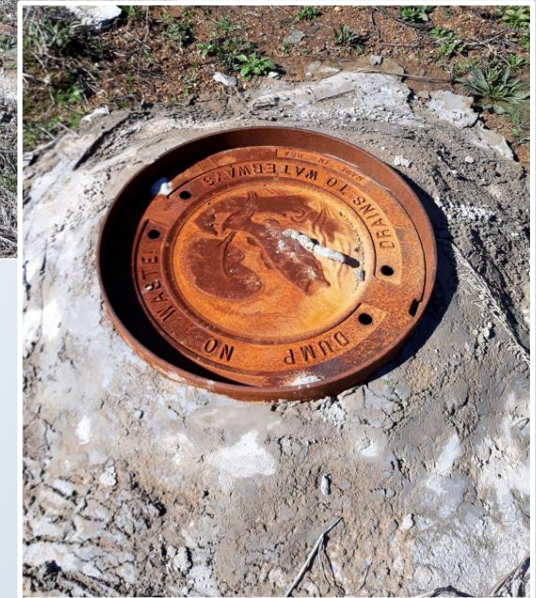
Case Study 2 - Garywood Pump Station – Red Farmer Rd

Problem and Background:

- During field review of the planned rehab project, it was found that a contractor had filled two vacant lots and redirected the stormwater runoff directly to the sanitary sewer system
- Manholes became flooded during rain events
- Contractor had also dislodged the frame and cover on one of the manholes which provided a large hole for the stormwater to enter the sanitary sewer system.

Solution:

- Regraded some areas
- Raised and sealed the manholes; replaced frame and covers where needed



Case Study 3 - McAlpine Pump Station

Problem and Background:

High R-value determined during flow monitoring and modeling

Federal flood zone buyout area; houses previously demolished under this program

Inactive sewers remained in system

Solution:

Plugged and disconnected “non-essential” sewers from the rest of the system

Reduced wet weather flows to some extent, but comprehensive sewer rehabilitation is still needed in this area



Case Study 4 - Fargo Drive/Foothills Drive Water Break

Problem and Background:

This area was identified for comprehensive rehabilitation due to high R values and recent SSOs

CCTV review revealed two lines with significant I/I (seemed pressurized)

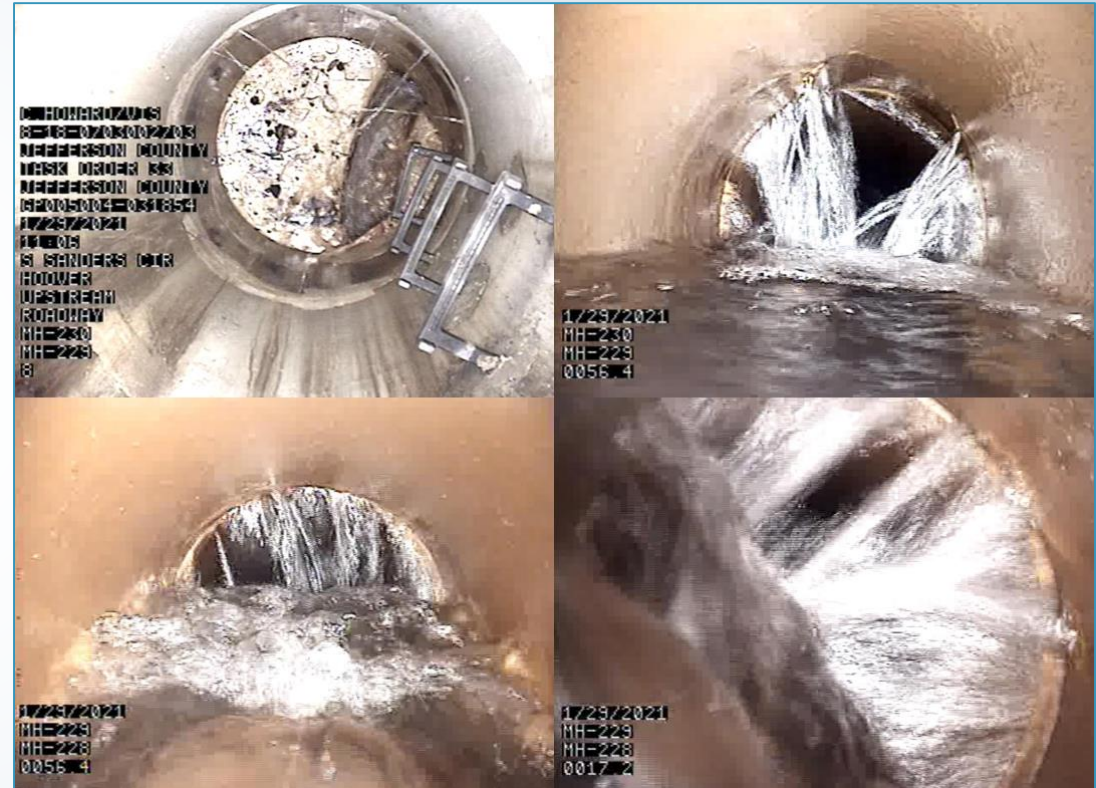
Solution:

Suspected water main break since the sewer was in a residential road

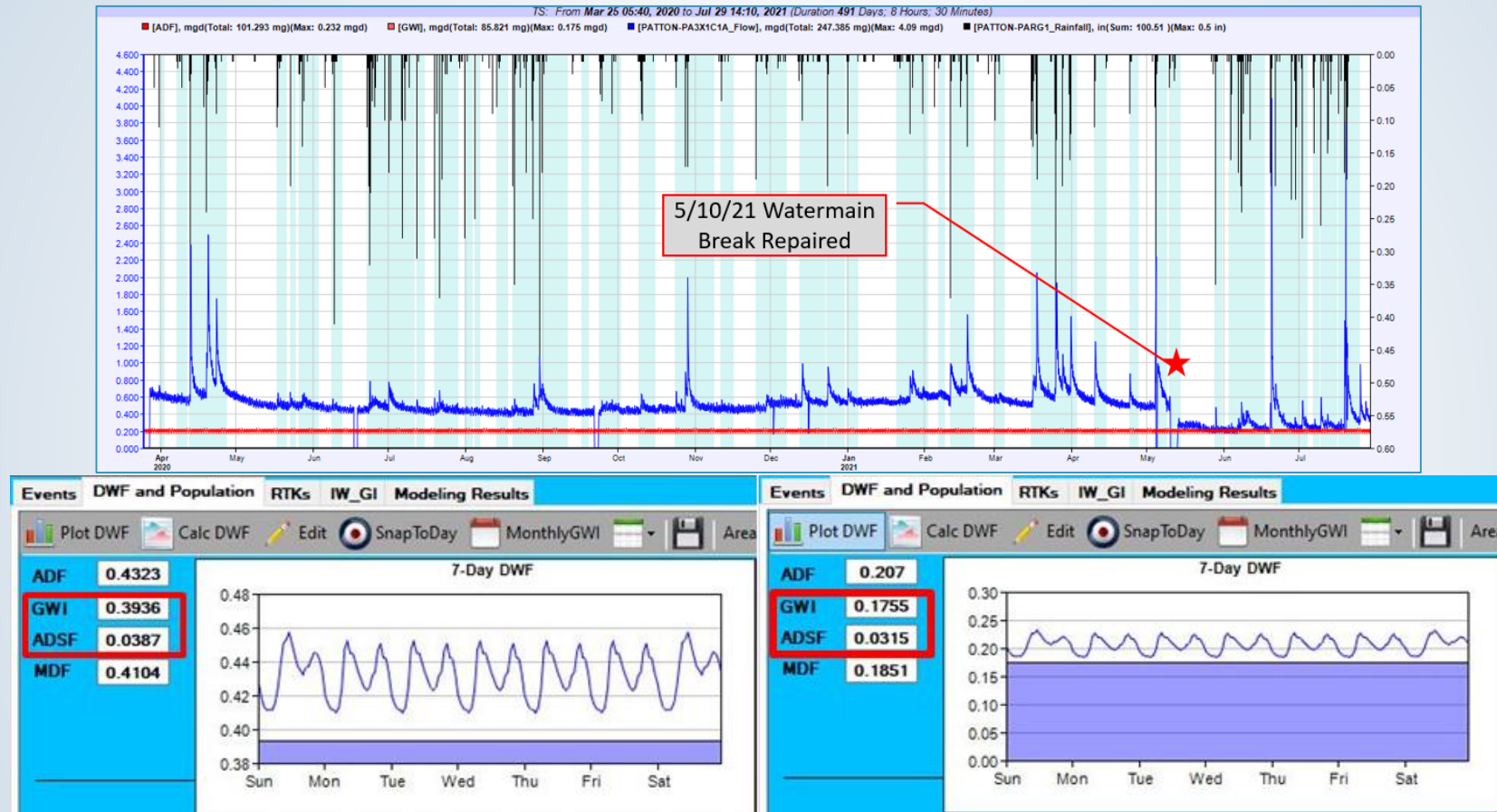
Notified Birmingham Water Works and the water main break was fixed

Flow meter information showed when the fix was made and reduced dry weather flow

Reduced dry weather flows but comprehensive sewer rehabilitation is still needed in this area



Case Study 4 - Fargo Drive/Foothills Drive Water Break



55% GWI reduction with no capital expenditures!

Summary

- Multiple steps are utilized to determine a target area for comprehensive sewer rehabilitation
- Careful planning, data review and field review have proven to be extremely beneficial while scoping out a project
- The detailed review might reveal a “quick fix” or even spur a different approach to the solution
- Has the potential for significant cost and time savings for your utility by eliminating RDII in some areas at a fraction of the cost of full comprehensive sewer rehabilitation
- Never know what you may find in your system when you look!



Acknowledgements

Jefferson County Environmental Services Staff

WCS Engineering

Diligent and Thorough Field Inspection Staff

Contacts:

Daniel White: whited@jccal.org

Tina Sheikhzeinoddin: tsheikhzeinoddin@hazenandsawyer.com

